Introduction

The United States Chemical Safety and Hazard Investigation Board (the Board or the CSB) is an independent federal agency whose mission is to investigate and promote the prevention of major chemical incidents at industrial facilities. The CSB is a scientific investigatory organization; it is not an enforcement body. In addition to conducting root cause investigations and reporting on findings, the Board has been directed by Congress to conduct special studies that encompass analyses of policy, guidelines, regulations and laws governing chemical safety.

On behalf of the Board, I welcome the opportunity to provide testimony on this important matter. The Board is thankful to the New Jersey Department of Environmental Protection (NJDEP) and the state's chemical-handling businesses, workforce and communities for your contributions to our understanding of reactive chemical hazards. New Jersey through the Toxic Catastrophe Prevention Act (TCPA) established one of the first, statewide accident prevention policies in 1985, much in advance of national policy. TCPA rules have served as a stimulus to other policy developments at the federal and state levels. The CSB congratulates the New Jersey Department of Environmental Protection for pursuing, through a public process, re-adoption of the Toxic Catastrophe Prevention Act rules to more fully cover reactive chemical hazards using objective criteria. Such action is consistent with the CSB's recommendation for federal policy improvements.

After providing background on the significance of chemical accidents and the CSB roles and responsibilities, CSB's comments focus on the findings, conclusions and recommendations of the CSB on Improving Reactive Hazards.[1] The Board is submitting a copy of this report for the hearing record.

Background

Chemical Accidents

The number and severity of U.S. chemical incidents manifest the need for public policy and institutions focused on preventing accidents. For example, among 14,500 chemical-handling facilities required to file risk management plans with the U.S. Environmental Protection Agency (EPA) in 1999, more than 1100 of these facilities reported approximately 1,900 accidents over the five-year period from 1994 through 1999. These incidents resulted in a total of 1,897 injuries, 33 deaths to workers/employees and evacuation or sheltering in place of over 200,000 members of the public[2]. The actual situation likely is underestimated by this federal inventory, since only one of the last

[1] "Improving Reactive Hazard Management, Chemical Safety and Hazard Investigation Board, Report No. 2001-01-H, October 5, 2002, Washington DC.
[2] See, Kleindorfer, P. et al., Center for Risk Management and Decision Processes, The Wharton School, University of Pennsylvania, http://opim.wharton.upenn.edu/risk/downloads/00-1-15.pdf

twenty incidents investigated by the CSB (many involving multiple fatalities) is required to be reported under the Risk Management Program (RMP).

Members of the insurance industry have recently estimated their direct losses from chemical releases as being about $1 billion dollars per year. Taking into account indirect losses and losses not covered by insurance companies, the losses would be conservatively estimated at least three to four times larger or three to four billion dollars annually.

CSB History and Structure

Following the catastrophic reactive incident at the Union Carbide facility in Bhopal, India in 1984[3] and a series of domestic incidents in 1987-1989,[4] the U.S. Congress authorized new chemical accident provisions through the Clean Air Act Amendments.[5] In addition to new regulatory approaches required of the Department of Labor's Occupational Safety and Health Administration (OSHA) and the EPA,[6] Congress mandated an independent Chemical Safety Board.

Modeled after the National Transportation Safety Board, CSB's authorizing statute provides for 5 Board Members, including a Chairperson, who are nominated by the President, by and with the advice and consent of the U.S. Senate. Members of the Board are appointed on the basis of technical qualification, professional standing and demonstrated knowledge in the fields of accident reconstruction, safety engineering, human factors, toxicology, or air pollution regulation. Board members, serving 5-year terms, govern by majority vote. The CSB began operations in January 1998.

Stimulus to regulatory assessments and recommendations

Congress explicitly recognized the Board's unique statutory mission, particularly as a stimulus to future regulatory assessments and recommendations, noting:

> *The independence of the Board . . . is essential for several reasons. First, it is unlikely that an agency charged both with rule-making and investigating functions would be quick to acknowledge that existing requirements were insufficient to prevent an accident . . .. Second, the Board is intended as an organizational stimulus to an appropriate amount of regulatory activity by the Environmental Protection Agency [(EPA)] in this area . . .. A Board which did not operate independent from the [EPA] Administrator's direction would defeat the objective of stimulating regulatory action -- a stimulus created through the*

[3] Lees, 1995 **Loss Prevention in the Process Industries, 2nd Ed**, App. 5; Lapierre, D and J. Moro, 2002. **Five Past Midnight in Bhopal**, Warner Books, NY.

[4] Most noteworthy among these incidents were: the Phillips Petroleum in Pasadena, TX, the Arco Refinery in Channelview, TX, Marathon Oil in Texas City, TX, and Shell Petroleum in Norco, LA.

[5] United States Clean Air Act, 42 USC §7412

[6] OSHA Process Safety Management (PSM) Standard (29 CFR 1910.119) and EPA Accidental Release Prevention Requirements: Risk Management Programs (RMP) Under the Clean Air Act, Section 112(r)(7) (40 CFR 68).

> *organizational tension built into the statutory relationship between the Board and the [Environmental Protection] Agency.* [7]

In particular, the Board is responsible for issuing periodic reports to the Congress, Federal, State and local agencies, concerned with the safe production, handling and storage of chemicals, and other interested persons. These reports can recommend: 1. measures to reduce the likelihood or the consequences of accidental releases; 2. corrective steps to make chemical production, processing, handling and storage as safe and free from risk of injury as is possible; and 3. proposed rules or orders which should be issued by the Secretary of Labor under the Occupational Safety and Health Act[8] or the EPA Administrator to prevent or minimize the consequences of any accidental release causing death, injury, other serious, adverse human health effects, or substantial property damage.

Hazard Investigations

Causation and recommendations from individual field investigations often reflect very specific aspects of manufacturing operations that typically use specialized procedures, equipment and technologies. However, occasionally in the course of conducting incident investigations, the Board is alerted to significant un-addressed safety problems that could affect a large number of facilities and are beyond the scope of any one particular investigation. As a result, the Board conducts a hazard investigation or safety study to better understand the nature and causes of such safety problems. Findings from a hazard investigation could lead to a variety of recommendations; these may or may not include proposals for regulatory action.

Improving Reactive Hazard Management

Introduction

The capability of chemical substances to undergo reactions, or transformations in their structure, is central to the chemical processing industry. Chemical reactions allow for a diversity of manufactured products. However, chemical reactivity can lead to significant hazards if not properly understood and controlled.

Reactivity is not necessarily an intrinsic property of a chemical substance under ambient conditions. The hazards associated with reactivity are related to process-specific factors, such as operating temperatures, pressures, quantities handled, concentrations, the presence of other substances, and impurities with catalytic effects.

Safely conducting chemical reactions is a core competency of the chemical manufacturing industry. However, chemical reactions can rapidly release large quantities of heat, energy, and gaseous byproducts. Uncontrolled reactions have led to serious explosions, fires, and toxic emissions. The impacts may be severe in terms of death and

[7] Senate Rept. No. 101-228 (Page 231).
[8] 29 U.S.C. 651 et seq

injury to people, damage to physical property, and effects on the environment. In particular, New Jersey incidents at Napp Technologies in 1995 and Morton International in 1998 raised concerns about reactive hazards to a national level. These and other incidents across the United States[9] underscored the need for the CSB to undertake a study to improve the management of reactive hazards.

CSB Findings Regarding Reactive Hazards

The limited data analyzed by CSB include 167 serious incidents in the United States involving uncontrolled chemical reactivity from January 1980 to June 2001. Forty-eight of these incidents resulted in a total of 108 fatalities. The data include an average of six injury-related incidents per year, resulting in an average of five fatalities annually. Nearly 50 of the 167 incidents affected the public.[10]

Over 50 percent of the 167 incidents involved chemicals not covered by existing OSHA[11] or EPA[12] process safety regulations. Approximately 60 percent of the 167 incidents involved chemicals that either are not rated by NFPA or have "no special hazard" (NFPA "0").[13] Only 10 percent of the 167 incidents involved chemicals with NFPA published ratings of "3" or "4."

For the purpose of the OSHA PSM Standard, National Fire Protection Association (NFPA) instability ratings have the following limitations with respect to identifying reactive hazards:

- They were originally designed for initial emergency response purposes, not for application to chemical process safety.
- They address inherent instability only, not reactivity with other chemical substances (with the exception of water) or chemical behavior under non-ambient conditions.

[9] For example: BPS, Inc., West Helena, Arkansas (1997), with three fatalities; Condea Vista, Baltimore, Maryland (1998), with five injured; Whitehall Leather Company, Whitehall, Michigan (1999), with one fatality; and Concept Sciences, Inc., Allentown, Pennsylvania (1999), with five fatalities and 14 injured.
[10] " Public impact" is defined as known injury, offsite evacuation, or shelter-in-place.
[11] In 1992, OSHA promulgated its Process Safety Management (PSM) Standard (29 CFR 1910.119). The standard covers processes containing individually listed chemicals that present a range of hazards, including reactivity, as well as a class of flammable chemicals. Reactive chemicals were selected from an existing list of chemicals identified and rated by the NFPA because of their instability rating of "3" or "4" (on a scale of 0 to 4).
[12] In 1996, EPA promulgated its Accidental Release Prevention Requirements: Risk Management Programs (RMP; 40 CFR 68) in response to the congressional mandate. Although this standard established new measures with regard to public notification, emergency response, and accident reporting, its requirements for managing process safety are similar to those of the OSHA PSM Standard. For purposes of this regulation, EPA identified covered substances based on toxicity and flammability–but not chemical reactivity.
[13] An NFPA instability rating of "0" means that materials in themselves are normally stable, even under "fire" conditions.

- NFPA Standard 49[14]–on which the OSHA PSM-listed highly reactive chemicals are based–covers only 325 chemical substances, a very small percentage of the chemicals used in industry.[15]

- The OSHA PSM Standard lists 137 highly hazardous chemicals–only 38 of which are considered highly reactive based on NFPA instability ratings of "3" or "4."

- The NFPA ratings were established by a system that relies, in part, on subjective criteria and judgment.

As a result of the joint OSHA-EPA chemical accident investigation of the Napp Technologies incident in April 1995, EPA and OSHA recommended consideration of adding more reactive chemicals to their respective lists of chemicals covered by process safety regulations. To date, neither OSHA nor EPA process safety regulations have been modified to better cover reactive hazards.

Reactive hazards are diverse. The reactive incident data analyzed by CSB included:

- Over 40 different chemical classes (i.e., acids, bases, monomers, oxidizers, etc.), with no single dominating class.

- Several types of hazardous chemical reactivity, with 36 percent attributed to chemical incompatibility, 35 percent to runaway reactions, and 10 percent to impact-sensitive or thermally sensitive materials.

- A diverse range of chemical process equipment–including reaction vessels, storage tanks, separation equipment, and transfer equipment. Storage and process equipment (excluding chemical reaction vessels) account for over 65 percent of the equipment involved; chemical reaction vessels account for only 25 percent.

- Reactive incidents can result in a variety of consequences, including fire and explosions (42 percent of incidents) as well as toxic gas emissions (37 percent).

No one comprehensive data source contains the data needed to adequately understand root causes and lessons learned from reactive incidents or other process safety incidents. Incident data collected by OSHA and EPA provide no functional capability to track reactive incidents so as to analyze incident trends and develop preventive actions at a national level.

[14] NFPA 49, Hazardous Chemicals Data (1975 Edition).
[15] The Chemical Abstracts Service maintains data on over 200,000 chemicals that are listed under national and international regulations.

Causes and lessons learned are reported in only 20 percent of the 167 incidents. (Industry associations, government agencies, and academia typically do not collect this information.) However, more than 60 percent of the incidents for which some causal information was available involved inadequate practices for identifying hazards or conducting process hazard evaluations; nearly 50 percent involved inadequate procedures for storage, handling, or processing of chemicals.[16]

Over 90 percent of the incidents analyzed by CSB involved reactive hazards that are documented in publicly available literature accessible to the chemical processing and handling industry.

Although several computerized tools[17] and literature resources are available to identify reactive hazards, surveyed companies do not generally use them. In some cases, these tools provide an efficient means of identifying reactive hazards without the need for chemical testing. Surveyed companies share chemical data of a general nature for most chemicals (e.g., material safety data sheets [MSDS]) and good handling practices for some. However, detailed reactive chemical test data, such as thermal stability data– which can be valuable in identifying reactive hazards–are not typically shared.

Approximately 70 percent of the 167 incidents occurred in the chemical manufacturing industry. Thirty percent involved a variety of other industrial sectors that store, handle, or use chemicals in bulk quantities.

Only limited guidance on the management of reactive hazards throughout the life cycle of a chemical manufacturing process is currently available to industry through professional societies, standards organizations, government agencies, or trade associations. There are significant gaps in the following:

- Unique aspects of reactive hazards that should be examined during process hazard analysis (PHA), such as the need for reactive chemical test data, and methods to identify and evaluate worst case scenarios involving uncontrolled reactivity.

- Integration of reactive hazard information into process safety information, operating procedures, training, and communication practices.

- Review of the impact on reactive hazards due to proposed changes in chemical processes.

- Concise guidance targeted at companies engaged primarily in the bulk storage, handling, and use of chemicals to prevent inadvertent mixing of incompatible substances.

[16] The summation of causal factor statistics exceeds 100 percent because each major incident can, and often does, have more than one cause.
[17] National Oceanic and Atmospheric Administration's (NOAA) The Chemical Reactivity Worksheet, American Society for Testing and Materials' (ASTM) CHETAH, and Bretherick's Database of Reactive Chemical Hazards.

Several voluntary industry initiatives, such as ACC's Responsible Care and NACD's Responsible Distribution Process (RDP), provide guidance on process safety management for chemical manufacturers and distributors. However, no voluntary industry initiatives list specific codes or requirements for reactive hazard management.

The EPA RMP regulation and the European Community's Seveso II directive both exempt covered processes from some regulatory provisions, if the facility documents the absence of catastrophic damage from process accidents under reasonable worst case conditions.

CSB Conclusions Regarding Reactive Hazards

1. Reactive incidents are a significant chemical safety problem.
2. The OSHA PSM Standard has significant gaps in coverage of reactive hazards because it is based on a limited list of individual chemicals with inherently reactive properties.
3. NFPA instability ratings are insufficient as the sole basis for determining coverage of reactive hazards in the OSHA PSM Standard.
4. The EPA Accidental Release Prevention Requirements (40 CFR 68) have significant gaps in coverage of reactive hazards.
5. Using lists of chemicals is an inadequate approach for regulatory coverage of reactive hazards. Improving reactive hazard management requires that both regulators and industry address the hazards from combinations of chemicals and process-specific conditions rather than focus exclusively on the inherent properties of individual chemicals.
6. Reactive incidents are not unique to the chemical manufacturing industry. They also occur in many other industries where chemicals are stored, handled, or used.
7. Existing sources of incident data are not adequate to identify the number, severity, and causes of reactive incidents or to analyze incident frequency trends.
8. There is no publicly available database for sharing lessons learned from reactive incidents.
9. Neither the OSHA PSM Standard nor the EPA RMP regulation explicitly requires specific hazards, such as reactive hazards, to be examined when performing a process hazard analysis. Given that reactive incidents are often caused by inadequate recognition and evaluation of reactive hazards, improving reactive hazard management involves defining and requiring relevant factors (e.g., rate and quantity of heat and gas generated) to be examined within a process hazard analysis.
10. The OSHA PSM Standard and the EPA RMP regulation do not explicitly require the use of multiple sources when compiling process safety information.
11. Publicly available resources[18] are not always used by industry to assist in identifying reactive hazards.
12. There is no publicly available database to share reactive chemical test information.

[18] NOAA's The Chemical Reactivity Worksheet, ASTM's CHETAH, and Bretherick's Database of Reactive Chemical Hazards.

13. Current good practice guidelines on how to effectively manage reactive hazards throughout the life cycle[19] of a chemical manufacturing process are neither complete nor sufficiently explicit.
14. Given the impact and diversity of reactive hazards, optimum progress in the prevention of reactive incidents requires both enhanced regulatory and non-regulatory programs.

The Board encourages the New Jersey Department of Environmental Protection to fully consider CSB's findings and conclusions as you finalize the re-adoption of the TCPA rules.

CSB Policy Recommendations

Most germane to New Jersey's Re-adoption of the TCPA rules, CSB recommended improvements in federal rules that govern process safety of hazardous chemicals. CSB has asked that OSHA amend PSM regulations[20] in four major respects:

1. Increase the coverage for combinations of chemicals that pose reactive hazards capable of being realized in a process.
2. Require facilities to consult and assemble important process safety information from specified sources prior to commencing operation of a PSM covered process,
3. Require that the process hazard analyses (PHA) required by the PSM address reactive hazards more effectively by requiring that the PHA consider a number of specified items such as, rate and quantity of heat or gas generated, maximum operating temperature to avoid decomposition, etc.,
4. Improve collection of data on reactive incidents that OSHA investigates or requires to be investigated under its regulations.

The Board notes that the proposed TCPA approach includes actions in line with the Board's recommendations to OSHA. In particular, the TCPA amendments seek to address the risks identified in the CSB Reactive Hazards Report by broadening coverage to encompass substances that pose reactive hazards. The Board also notes that the TCPA makes use of specific objective criteria, such as the heat of reaction to define Reactive Hazard Substance (RHS) Mixtures.

[19] "Life cycle" refers to all phases of a chemical manufacturing process–from conceptualization, process research and development (R&D), engineering design, construction, commissioning, commercial operation, and major modification to decommissioning.

[20] CSB specifically requests that OSHA "1. Amend the Process Safety Management (PSM) Standard, 29 CFR 1910.119, to achieve more comprehensive control of reactive hazards that could have catastrophic consequences. Broaden the application to cover reactive hazards resulting from process-specific conditions and combinations of chemicals. Additionally, broaden coverage of hazards from self-reactive chemicals. In expanding PSM coverage, use objective criteria. Consider criteria such as the North American Industry Classification System (NAICS), a reactive hazard classification system (e.g., based on heat of reaction or toxic gas evolution), incident history, or catastrophic potential."

The CSB plans to study the comments of stakeholders on the TCPA proposal so that it may learn, and share with others ways in which its general recommendations on reactive hazards can most effectively be translated into workable, risk reduction regulations

Also noteworthy to the NJDEP, given the state's actions regarding incorporation of EPA RMP provisions into the TCPA, the CSB issued a related recommendation to EPA to improve coverage of reactive hazards under its RMP standard.[21] In essence, this recommendation suggested that EPA adopt an approach consistent with any changes adopted by OSHA in response to the Board's recommendations to them.

Summary

The U.S. Chemical Safety Board is a relatively new model for independent public agency whose mission is to investigate and promote the prevention of major chemical incidents at industrial facilities. As a scientific investigatory organization free from enforcement responsibilities, the Board conducts root cause investigations and special studies that encompass analyses of policy, guidelines, regulations and laws governing chemical safety.

The Board is thankful to the Department of Environmental Protection and the New Jersey chemical-handling businesses, workforce and communities for your contributions to our understanding of reactive chemical hazards. New Jersey through the Toxic Catastrophe Prevention Act (TCPA) established one of the first state accident prevention policies in 1985. TCPA rules have served as a stimulus to other policy developments at the federal and state levels. The CSB congratulates the New Jersey Department of Environmental Protection for pursuing, through a public process, re-adoption of the Toxic Catastrophe Prevention Act rules to more fully cover reactive chemical hazards using objective criteria. Such action is consistent with the CSB's recommendation for federal policy improvements.

[21] CSB specifically requests that EPA "Revise the Accidental Release Prevention Requirements, 40 CFR 68 (RMP), to explicitly cover catastrophic reactive hazards that have the potential to seriously impact the public, including those resulting from self-reactive chemicals and combinations of chemicals and process-specific conditions. Take into account the recommendations of this report to OSHA on reactive hazard coverage. Seek congressional authority if necessary to amend the regulation."